

Bid Specification**Prefabricated Relocatable Classroom Building
(General Requirements)****Collaborative for High Performance Schools (CHPS)****3.9 Heating, Ventilating, Air Conditioning (HVAC):****3.9.1 Heat Pumps**

3.9.1.1 All work shall be in full accordance with applicable editions of American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Standards.

3.9.1.2 Type IV buildings shall be provided with one primary and one auxiliary heat pump. All other buildings shall be provided with a single primary heat pump. In addition, electric cooling, gas heating, and gas cooling units may be installed upon written request from the purchaser and with written approval from the California Energy Commission. All such units shall meet or exceed minimum energy performance standards.

3.9.1.3 Contractor shall furnish and install one-piece, wall mounted, factory-assembled, precharged, prewired, tested and ready-to-operate heat pump unit(s). The unit(s) shall be approved and listed by Underwriters' Laboratories, Inc. or other nationally recognized safety testing organization. Performance of units shall be certified in accordance with Air Conditioning and Refrigeration Institute Standard 390-2003 for single package vertical units (SPVU) Heat Pumps, latest edition..

The one-piece, wall-mounted system will comply with the following operational specifications:

3.9.1.3.1 Energy Efficiency:

The system shall have a Seasonal Energy Efficiency Ratio Rating (SEER) of at least 13.0 as defined by ARI Standard 210-240-2003 (ARI 2003a)

Or, as appropriate ARI Certification Programs or other standards bodies' metrics change:

The system shall have a minimum cooling efficiency of 10.5 EER and 14.0 IPLV [Integrated Part Load Value] for units four tons capacity and less. For systems above 4 tons of capacity the minimum cooling efficiency of 9.0 EER and 13.7 IPLV. All systems must meet a minimum of 3.2 COP heating efficiency when tested in accordance with ARI Standard 390-2003 at 47°F outdoor ambient temperature in stage 2 (ARI 2003b).

3.9.1.3.2 Physical Package

The HVAC system shall meet general physical dimension and integration characteristics suitable for mounting on new and existing relocatable classrooms in CA. In the case of replacement of HVAC systems in relocatable classrooms the system must be designed so that no internal wall or external siding need be removed or replaced, and framing changes are restricted to the addition

of bracing and blocking within existing openings (intent of this language: direct HVAC replacement without significant extra installation labor and materials).

3.9.1.3.3 Ventilation System Improvement:

Outside air supply

The HVAC system shall provide sufficient outside air ventilation flow for up to 32 occupants (ASHRAE standard 62.1-2004: 480 CFM), continuously.

The ventilation system shall be capable of providing continuous ventilation with outside air intake and exhaust built into the wall mounted HVAC system. This shall operate at a maximum of 0.17 KW of circulating fan power at 0.3 inches of ESP during ventilation mode at a maximum of 35± 2dB(A) sound pressure level when measured at the same locations as described in 'Noise Reduction' outlined above.

3.9.1.3.4 Controls

The HVAC system controls shall provide signals to the air handler to constantly and continuously ventilate during occupancy irrespective of thermal demand to meet California's energy efficiency standards and ASHRAE 62.1 recommendations (CEC 2004; ASHRAE 2004)

The HVAC system will automatically provide California Title 24 pre-occupancy ventilation requirements of 3 room air changes prior to scheduled occupancy (CEC 2004).

The HVAC system shall be capable of maintaining indoor CO₂ concentrations at levels no more than 600 ppm above those outside for averaging periods of 5 minutes or greater (CEC 2004; ASHRAE 2004a).

3.9.1.3.5 Thermal conditioning:

The HVAC system shall provide thermal conditioning at air velocities and temperatures that meet ASHRAE 55 thermal comfort standards. Note: thermal comfort as defined by ASHRAE Standard 55 may not be met without additional humidity control in conditions where outdoor relative humidity levels are outside of those prescribed in that standard (ASHRAE, 2004b). However, the system design should include all practical steps to ensure that the conditioned space humidity levels are maintained close to those designated in ASHRAE Standard 55.

3.9.1.3.6 Refrigerant:

The new system shall use an alternative to an HCFC refrigerant in anticipation of the 2010 HCFC refrigerant phase-out (USEPA, 2004).

3.9.1.4 The HVAC system shall maintain an automatically controlled indoor classroom temperature of 78°F in summer and 68°F in winter with a 60% relative humidity when the outdoor temperatures vary as indicated below:

<u>Building Type</u>	<u>SUMMER</u>	<u>WINTER</u>
Type I	92°F db/72° F wb	+10°F db
Type II	92°F db/72° F wb	+10°F db
Type III	92°F db/72° F wb	- 10°F db
Type IV	114°F db/72° F wb	+10°F db

Calculations shall be based on 32 occupants. The mechanical ventilation system shall provide a minimum of 15 cubic feet of outside air per minute per occupant. (15 cf x 32 = 480 cfm)

- 3.9.1.5** Compressors shall be welded hermetic type with built-in thermal and over-current protective devices and a 5-year warranty on all parts.
- 3.9.1.6** Coils shall be of copper tube construction with mechanically bonded aluminum plate fins.
- 3.9.1.7** Indoor coil blower shall have a direct drive forward curved centrifugal impeller that delivers a maximum of 1700 cfm (primary heat pump) of air through a wet coil with an external static pressure of 0.20 esp at high speed. Twin blowers are acceptable.
- 3.9.1.8** Propeller type outdoor coil fan shall discharge horizontally along the wall and be direct driven.
- 3.9.1.9** Controls shall be factory wired and located in a readily accessible location on the unit. Fan motors shall have both thermal and current sensitive overload devices. Control circuit transformer shall be factory installed. Line voltage circuit breaker or pull disconnect with lockable cover shall be supplied on each unit and shall be easily accessible without removing any unit panels.
- 3.9.1.10** Cabinet shall be a single, enclosed, weatherproof casing constructed of minimum 20 gauge galvanized steel. Each exterior casing panel shall be finished with enamel paint prior to assembly. Cooling section shall be fully insulated with 1-inch fiberglass to prevent sweating and to muffle sounds. Openings shall be provided for power connections. Access openings for all fan motors and compressor shall be designed so that repairs and removal of internal components can be accomplished without removing the unit from its permanent installation. Full-length side mounting brackets shall be provided. Fresh air intake and outdoor coil shall be protected from intrusions by a sturdy metal grating.
- 3.9.1.11** Cooling coil condensate shall be drained to a point a minimum of 3 feet from building. Outdoor coil shall have an auxiliary drain pan.
- 3.9.1.12** Outdoor air shall be filtered through the easily inspected and replaceable filtering system. Each building shall be tagged with a minimum 4" x 2" engraved plastic adhesive-backed label mounted on face of the thermostat with the following information:
- California State Law Title 24 requires continuous ventilation in this room whenever occupied.
 - IF THERMOSTAT IS NOT PROGRAMMED FOR VENTILATION:
 1. Set thermostat fan switch to ON when room is occupied
 2. Return switch to AUTO when room is vacant
 - CHPS recommends the replacement of the 20" x 30" x 2" pleated heat pump filter (MERV 6 or higher) every thirty days.
 - Type IV secondary unit 16" x 30" x 2" pleated filter.
- 3.9.1.13** Primary heat pump shall have a minimum total cooling capacity of 42,000 BTU/HR with an outdoor temperature of 90°F and a returning air temperature of 80°F db/67°F wb (no outdoor air).

- 3.9.1.14** For Types I, II, and IV buildings, a minimum of 10Kw electric resistive heating shall be provided on primary heat pump. The resistive heating shall be configured so that it can be changed to approximately 5 Kw capacity or 0 Kw capacity. Controls shall be configured so that heat pump compressor and resistive heating can operate simultaneously. For Type III (Snow Load) buildings, a minimum of 20 Kw electric resistive heating shall be provided.
- 3.9.1.15** The unit shall be installed in strict accordance with manufacturer's instructions with particular attention to required flashing. Manufacturer's literature, certified ventilation tables, operating instructions and guarantee shall be delivered to the school district of child care agency at the time the building is delivered.
- 3.9.1.16** Optional: An economizer capable of modulating outside-air and return-air dampers to supply 100 percent of the design supply air quantity as outside air shall be installed. Damper system shall automatically open to admit outdoor air when unit is on and automatically close when unit is off or power is lost. Damper system shall be approved by U.L. or other nationally recognized safety-testing agency. It shall be capable of providing partial cooling even when additional mechanical cooling is required to meet the remainder of the cooling load and shall meet the following requirements:

- Factory or field-installed and fully run-tested and field verified
- Differential (dual) changeover logic is optional
- Low leakage dampers
- Economizer check should follow test procedures required by the Title 24 2005 Standards, Appendix NJ.7.1.

An economizer should be included where conditions permit outside air to provide cooling benefit without the need for air conditioning and other external conditions (noise, poor air quality etc.) preclude the use of natural ventilation by opening windows and doors.

3.9.2 **Ductwork**

- 3.9.2.1** Ductwork shall be constructed of galvanized sheet metal in accordance with Uniform Mechanical Code and SMACNA Low Velocity Duct Construction Manual, latest editions. All ductwork shall be designed at .2 ESP and insulated with minimum 1" thick fiberglass duct wrap with vapor barrier. A minimum of 1" duct noise attenuation material shall be provided at all ductwork within 8'-0" of HVAC unit. Air handling ducts and plenum shall be mechanically fastened and then sealed with mastic and mesh tape in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, latest edition. Pressure sensitive tape shall not be allowed for sealing. Primary and auxiliary heat pumps shall each be provided with their own duct systems. Primary and auxiliary duct systems shall not be connected.

Non-Metallic Ductwork Option: In accessible concealed portions of duct system, rigid 1" fiberglass or insulated "Flexduct" with vapor barrier may be substituted for sheet metal ductwork. All ductwork within 5' of the HVAC unit and all interface connections shall be metal. Ductwork and reinforcement shall be designed for 2" static pressure. If used, ducts shall be Owens-Corning Fiberglass Duct Board, Manville Micro-Aire Type 475, or equivalent approved in advance and in writing by PD and the owner. Non-metallic ductwork shall conform to NFPA 90-A and 90-B and SMACNA Class I rating. If "flexduct is used, a minimum of three 12" round ducts shall be required. Flexible ducts shall be mechanically fastened using straps and beaded collars at all connections.

In addition flexible duct connections shall be sealed with mastic or a pressure sensitive tape (UL181B-FX) applied prior to the straps.

- 3.9.2.2** Each duct system (3 minimum) shall be provided with a 16" x 16" fixed curve blade T-Bar diffuser without an OBD (non perforated face) similar to Shoemaker series 104 with a 16" x 16" lined sheet metal side outlet box with a 12" collar. Adjustable dampers to be located on the supply plenum to control air volume. The Noise Criteria (NC) rating shall not exceed 25. Intent of this design is to meet required acoustic noise levels as defined in section 3.9.1.3.
- 3.9.2.3** Wrap and seal all ductwork and other HVAC components during storage and transportation to avoid infiltration of dust, debris, and other contaminants.
- 3.9.3** Thermostat: Contractor shall provide a thermostat for the primary heat pump with the following functions: 5 and 2 weekday/weekend programming with minimum of 4 separate time/temperature settings per 24-hour period, keyboard lockout switch, programmable display, minimum 2 hour override, status indicated LEDs, and battery back-up or EEPROM memory. A locking clear thermostat cover with access hole for program override shall be provided. A thermostat cable to provide all necessary functions shall be supplied between thermostat and heat pump.
- 3.9.4** Ventilation Controller (optional): A ventilation controller shall be provided that monitors the carbon dioxide level in the classroom air and controls the ventilation by opening or closing the outside air damper. The minimum position of the damper shall be determined by minimum outside air flow based on 0.15 cfm/sq. ft. Any other position shall be determined by CO₂ controller demand or economizer demand, whichever is higher. Controller shall display CO₂ levels on a built-in display from 0-5,000 ppm. In addition, a flag shall be provided for high CO₂ warning and CO₂ analyzer failures. A mechanical clamp shall also be provided to prevent the outside air damper from going below the minimum required outside air position. Unit shall be designed so that those users can set the point at which the damper opens and goes to a minimum position. The damper will modulate between these points unless a higher opening is demanded by the economizer. Controller shall be initially set so that the damper opens at 800 ppm and goes to a minimum position at 600 ppm. Unit shall have a recommended calibration interval not to exceed 5 years. Controller shall be located on an interior wall no higher than 5 feet above the floor and provided with a wire bail guard that is screwed to the wall. Controller shall be Telaire 8002 or Honeywell C7242A or equivalent approved in writing by Procurement Division after June 1, 1999, and shall be certified by the California Energy Commission.
- 3.9.5** Air Balance Test: Contractor shall perform an air balance test. Test shall determine optimum position of diffuser dampers and position of ventilation damper that will provide 390 cfm of outside air. Test shall be witnessed and verified by the inspector of record.
- 3.9.6** Noise Criteria: The system, including supply and return registers and all ducting, shall operate in an unoccupied room at a sound level of 45± 2 dB(A) at a distance of 10 feet, normal to, and at a 45 degree angle from the air return, measured five feet above the floor at the same location in its noisiest operating condition (CHPS 2002). The background sound pressure level measurement during the above described test conditions with all sound producing equipment (e.g., fluorescent lights, computer equipment, clocks, fans, etc.) should not contribute more than 25 dB(A) to the room noise. If achievement of sufficiently low indoor background sound pressure levels is not possible, normalization to 25dB(A) background level is acceptable provided that the measured sound pressure level with the HVAC equipment turned on at its quietest setting is at least 10 dB(A) higher than the level with the HVAC equipment turned off. Note that due to the logarithmic nature of the decibel, mathematical manipulation of acoustic data requires special procedures (see ASHRAE 2005)

3.9.6.1 Noise Criteria Option [If specified]: To achieve the desired 45 dB(A) sound performance level or an optional lower unoccupied room sound level of 40 dB(A) or less, at a distance of 10 feet normal to and at an angle of 45 degree operating condition the following additional items may be desirable and if specified shall be factory supplied by the HVAC manufacturer to achieve the additional acoustical noise reduction benefits: [a] Supply Air Acoustical Plenum – transitions from the rectangular HVAC supply air outlet to three 12 inch diameter round supply duct connectors designed to significantly reduce breakout noise from the supply plenum and [b] a Return Air Acoustical Plenum-suitable for vertical, horizontal left or horizontal right installation from the HVAC unit return air opening. The Return Air Acoustical Plenum shall permit the proper design ventilation and supply air flow without excessive pressurization of the room, and shall prevent excessive air restriction in the internal return air path. It shall also be designed to discourage external blockage by occupants of the return air inlets: [c] Isolation Curb - For mounting the HVAC unit on frame construction it is recommended to specify a factory designed and produced Isolation Curb to retain complete rubber isolation between the HVAC unit and the wall-mounting surface. The curb to be a direct bolt on device to attach to the wall surface and include provisions for direct bolting of the HVAC unit directly to the curb. The curb shall have built-in fully supply and return openings and connection flanges that can be fully sealed against leakage at their joints with HVAC unit and plenums.

3.9.7

References

- ARI. 2003a. 2003 Standard for Unitary Air-Conditioning and Air-Source Heat Pump Equipment, Standard 210/240, Air-Conditioning and Refrigeration Institute, Arlington VA, 22203
- ARI. 2003b. 2003 Standard for Performance Rating of Single-Package Vertical Air-Conditioners and Heat Pumps, Standard 390, Air-Conditioning and Refrigeration Institute, Arlington VA, 22203
- ASHRAE 2005. *2005 ASHRAE Handbook: Fundamentals*, SI Edition. Atlanta, GA, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
- ASHRAE. 2004a. ANSI/ASHRAE 62.1, *Ventilation for acceptable indoor air quality*. Atlanta, GA, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
- ASHRAE. 2004b. ANSI/ASHRAE 55-1992, *Thermal environmental conditions for human occupancy*. Atlanta, GA, American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc.
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- CHPS. 2002. "HVAC Best Practices Manual," Collaborative for High Performance Schools, CHPS Inc. <http://www.chps.net/manual/index.htm>
- USEPA. 2004. "40 CFR Part 82. Protection of Stratospheric Ozone: Allowance System for Controlling HCFC Production, Import and Export; Direct Final Rule and Proposed Rule." *Federal Register* 69(116):34024-34033.